

Thermoflooring: Product Development and Performance

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ABSTRACT

Floorings made of solid wood have to cope with the fact that timber responds to the surrounding climate by changing its moisture content (MC) and as a result is changing its dimensions. For a floating floor system (where there is no connection between the wooden floor and the underlying floor) these changes have to be minimized in order to avoid gaps and buckling. As *thermally modified timber (TMT)* reacts with lower changes in MC which results in less dimensional changes as natural timber, *TMT* is a favourable material for using it for solid floating floors. For easy laying the developed flooring provides a glueless connection system. Due to this fact two main factors have to be considered: while the moisture content should be as low as possible, guaranteeing dimensional stability, the mechanical strength properties should be decreased as little as possible. Different wood species have got different changes in MC, which does not change by modifying the timber. Therefore suitable wood species and floor plank dimensions had to be defined. Ash modified as “*Ash Mezzo*” and “*Ash forte*” (Thermoholz Austria GmbH) seemed to be the most promising material for the planned floor system. Other suitable wood species are Maple (“*Maple Forte*”) and Birch (“*Birch Mezzo ex.*”). To evaluate the usability of the glueless locking system in combination with *TMT*, the strength properties of *TMT* had to be evaluated and practical tests of the flooring were indispensable. To perform these tests, the developed flooring was installed in different locations, in an office (Mitteramskogler GmbH, Austria), in a sleeping room and an office (Välinge Innovation AB, Sweden), in a corridor (Profactor GmbH, Austria) and above a floor heating system (Hareither GmbH, Austria). Additional results had been gathered at the fair “*Casa Decor*” in Barcelona in 2007 and 2008 where project partner Gothic installed the flooring at his booth and evaluated its behaviour.

INTRODUCTION

State of the art for floating floorings is the use of multilayered (2 or 3 layers) wood based materials, with a top layer of the favoured wood species. Solid wooden floorings are fixed to the under-floor by nailing or gluing, as possible dimensional changes impede its use as a floating floor. Nevertheless, for solid wooden floorings just a few wood species are suitable (e.g. oak) and the dimensions of the floor boards are limited. The dimensions depend generally on the wood properties and the possibilities of secondary cutting, regarding an optimum yield. For the new developed floor system the main limiting factor is the treatment class, as the treatment affects the strength properties. The favoured dimensions have been defined as follows: a length between 750-1100 mm, a width between 100-110 mm and a thickness of 10.4 or 14 mm. Because of the best combination of the properties regarding mechanical strengths and

dimensional stability “*Ash Mezzo*” has been chosen as the most appropriate wood species for this application. As the development of new products always demand sufficient information about the raw material, the production process and the behaviour of the finished product, tests have been performed to predict the performance of the new product.

FLOOR SYSTEM

Development

Some main questions determined the development of the floor system. Are the basic material properties of *TMT* suitable for its use as a flooring material? Is it possible to optimise the modification process with regard to the needed properties for flooring material? What surface properties can be achieved applying functional surface treatments, e.g. sol-gel treatment? Can the new developed flooring fulfil the performance requirements in the relevant product standards for CE-certification? And at last the new products should be serviceable in renovation like laminate flooring to offer new fields of application or solid wood floorings.

The design of the locking system has been developed and tested by Välinge AB, Viken, Sweden (Figure 1).

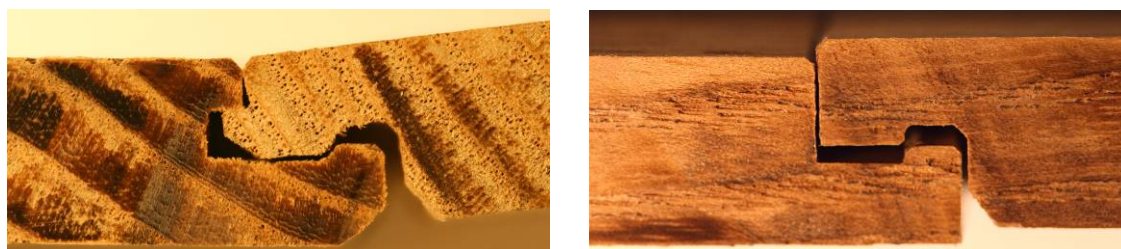


Figure 1: left: locking system long side, right: locking system short side without vertical locking

For the development of a glue less locking system for *TMT* further material parameters beside the wood properties have been collected, like the pull off strength of the locking system. Due to the limited strength properties of the source material some limitations resulted regarding the minimum thickness of the floor planks and modification level of the raw material. The minimum thickness is 10.5 mm for the lowest treatment class “*mezzo*”. Using higher modification levels, the thickness of the floor planks have to be increased. For the treatment class “*forte*” for example, tests have shown that only thicknesses of at least 14 mm provide acceptable results. As the width of the floor boards is maximal 110 mm, the developed short side locking system works without vertical locking.

Tests

The investigations covered material properties, mainly concerning treatment optimisation and future CE-certification and the overall performance of installed floorings.

Material

The material test covered three main areas, at first the basic material properties of *TMT* (various wood species and heat treatments) used for the characterisation of the

properties of the raw material and for the optimisation of the heat treatment processes, secondly the surface properties achieved by functional surface treatments and thirdly the performance characteristics of the flooring elements regarding product standards and CE-certification. The results of the investigations allowed a detailed assessment of relevant material properties and performance characteristics of the developed *Thermoflooring* products and provide a basis for a future product certification.

Floor

To test the performance of the flooring some test areas with different uses and surface treatments have been installed. To test the glue less locking system two types of floorings have been installed. At the Casa Décor 2007 TMT “*beech forte*” with a thickness of 14 mm has been used. This material has been chosen as colour and appearance fitted to the exhibited furniture. As surface treatment for this floor manually coated bee-wax has been applied. At the Casa Décor 2008 and for the other test areas TMT “*ash mezzo*” with a thickness of 10.4 mm has been chosen to test the target material thickness of 10.4 mm. For two test areas (office and test floor above floor heating) lacquer has been applied. For two other test areas (office and sleeping room) the surface of the floor boards has been oiled. The focus at the test area at Profactor was to test the performance of Sol-gel coating systems. For a visual comparison *app.* 2 sqm² of the test area have been coated with standard lacquer, *app.* 1 m² has been oiled and *app.* 9 m² have been coated with a Sol-gel coating system from Profactor, developed within the project “Hollywood”. The test areas have been installed during spring and summer 2007.



Figure 2: Thermofloor “ash mezzo” at the fair “Casa Décor” 2008, Barcelona, Spain

Results

The results of the material tests achieved do not differ much from already known data about thermally modified hardwoods. The optimisation of the treatments resulted mainly in choosing the lowest possible treatment temperature in order to keep the mechanical properties at a high level, despite the slighter changes for other properties like moisture content and therefore a lower dimensional stability. The main limiting parameter is the increased brittleness due to the modification, as this leads to a higher risk of breaking off tongues and edges of the boards. Nevertheless, providing a proper

production the pre-test for CE-certification showed that a CE-certification is possible for *Thermoflooring* at comparable efforts like untreated wood.

All installed floors show a good visual appearance and seem to be suitable for the intended uses. Even the floor above the floor heating shows no gaps although the surface temperatures of the wood have been raised up to 50 °C for 5 days to test the performance under higher temperatures. The surfaces of the floors at the fair booth and at the offices show some scratches and marks which can hardly be avoided under heavy use (*esp.* heels, gravel and moving of furniture, Figure 2). The dimensional stability of *TMT "Ash mezzo"* seems already sufficient enough using the material for producing floor planks with a glue less locking system even at the chosen thickness of 10.4 mm. Compared with other floorings, the thermally modified ones showed a great dimensional stability, as there was a very hot and dry climate within the exhibition (temperatures up to 30 °C). Other wooden floorings showed gaps up to 2 - 8 mm. All test floors show no cupping and warping, no visible gaps between the individual boards due to only slight dimensional changes.

CONCLUSIONS

TMT, especially thermally modified ash are a suitable material to produce solid wooden floorings with a glue less connection system. Provided that the treatment process is optimised regarding mechanical properties *Thermoflooring* can be produced at thicknesses down to 10.5 mm thus allowing a wide range of use even for renovation purposes. The glue less connecting system provides an easy installing of the floor. A final solution for the product *Thermoflooring* depend on the final producer of the floor boards as the locking system design and tool design is highly dependent on both the production process, *e.g.* machinery and the marketing position that the producer chooses. Provided a proper treatment and a careful production, *Thermoflooring* elements can fulfil the requirements of the relevant product standard EN 13228. The evaluation of conformity for a CE-Certification according to EN 14342 may be based largely on related, already existing test data.

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